Hydrology Report for the Sheep Chicken VMP

By Dana M Nave, 5 March 2021

Summary

On a scale of excellent-good-fair-poor, the hydrologic condition of the Sheep-Chicken Vegetation Management (Sheep) analysis area is good: low-to-moderate amounts of bank trampling and riparian browse, recent wood additions through stream restoration projects, little evidence of sediment entering streams from roadways, minor reductions to canopy closure in RHCAs for stream restoration projects, and minor recreation impacts. Stream temperatures are elevated above state standards in most streams with the greatest departure in Sheep Creek and West Chicken Creek. Stream restoration efforts are ongoing in both creeks with one of the goals to reduce stream temperature. Alternatives 2 and 3 differ very little in terms of hydrologic impact, and Alternative 2 is preferred for the RHCA treatments.

Physiography

The Sheep analysis area straddles the Chicken Creek and Sheep Creek Subwatersheds within the Headwaters Grande Ronde River Watershed in the Upper Grande Ronde Subbasin.

Table 1. Subwatersheds within the project area boundary.

Subwatershed	Hydrologic Unit Code 12
Chicken Cr	170601040104
Sheep Cr	170601040105

Major creeks within the project area are Sheep, East Sheep, Chicken, West Chicken and Indiana Creeks. All of these creeks flow into Sheep Creek which flows into the Grande Ronde River.

Elevations range from 4,200 to 6,600 feet and average annual precipitation amounts range from 24.5” to 33.4” with the lowest values at the lowest elevation in the “hat” of the project area and the highest values found in the headwaters of Indiana Creek.

Table 2. Indicators and Measures

Indicator	Measure
Estimated change in Stream Temperature	Acres of treatment within primary shade zone by stream, approximately 50 feet
Estimated change in Sedimentation from transportation system	Miles of temporary road in RHCAs

Stream Temperature

The Oregon Department of Environmental Quality (ODEQ) issues an Integrated Report every two years which is a water quality assessment of all water bodies in the state. The most recent Integrated Report came out in 2020 and includes stream temperature data submitted by the Forest up through 2018 (ODEQ 2020). The format of the Integrated Report has changed: instead of a written report, it is composed of an online searchable database and web-based map application. Click 2018/2020 Integrated Report - EPA Approved (arcgis.com) to access more information through an interactive Story Map or https://www.oregon.gov/deq/wq/Documents/irFS1820.pdf for a 2-page Fact Sheet.

ODEQ’s 2018/2020 Integrated Report divides the state’s waterbodies such as streams, rivers and lakes into assessment units (AU) based on similar hydrology and environmental/hydrographic characteristics.

Larger streams segments (Strahler stream order 5 or higher) are delineated by a change in designated use, stream order or watershed (HUC-10) boundary, whereas smaller streams are grouped at the subwatershed (HUC-12) level. When a subwatershed has been identified as impaired (Category 5A), it indicates that an impairment exists within the subwatershed, not that the entire subwatershed is impaired.

An AU is impaired if data indicate that at least one beneficial use is not being fully supported and a Total Maximum Daily Load (TMDL) Assessment is needed to address the issue. A TMDL is a pollution reduction plan which essentially removes streams previously on the Clean Water Act Section 303(d) list and makes them "Category 4A" which means they are still water quality limited, but with an approved TMDL. The Upper Grande Ronde Subbasin has a TMDL that was completed by ODEQ in 2000 (ODEQ 2000) and an associated Water Quality Management Plan completed by the Grande Ronde Water Quality Committee the same year (GRWQC, 2000).

The beneficial use most often not being supported is Fish and Aquatic Life Support. According to the 2018/2020 Integrated Report, this beneficial use is not being fully supported in both Chicken and Sheep Subwatersheds because of higher stream temperatures, habitat modification and sedimentation. Sheep Creek itself is water quality impaired for those same pollutants from its mouth at the Grande Ronde River up to its confluence with East Sheep Creek. In my opinion, the habitat modification and sedimentation parameters in both subwatersheds could use an updated assessment. Integrated Report findings for the Sheep project area is summarized in Table 3 below.

Table 3. 2018/2020 Integrated Report Results

Assessment Unit	Beneficial Use	Parameter Impaired (Category 4A)	Year Listed	Assessed in 2018
Sheep Creek, Chicken SWS & Sheep SWS	Fish and Aquatic Life Support	Temperature – Year Round	2002	Yes
Sheep Creek, Chicken SWS & Sheep SWS	Fish and Aquatic Life Support	Sedimentation	2002	No
Sheep Creek, Chicken SWS	Fish and Aquatic Life Support	Habitat Modification	2002	No
Sheep Creek, Chicken SWS	Fish and Aquatic Life Support	Temperature Spawning	2018	Yes

Figure 1 shows the stream temperature monitoring locations in the Sheep analysis area over the past 10 years and results from that monitoring are shown in Table 3.

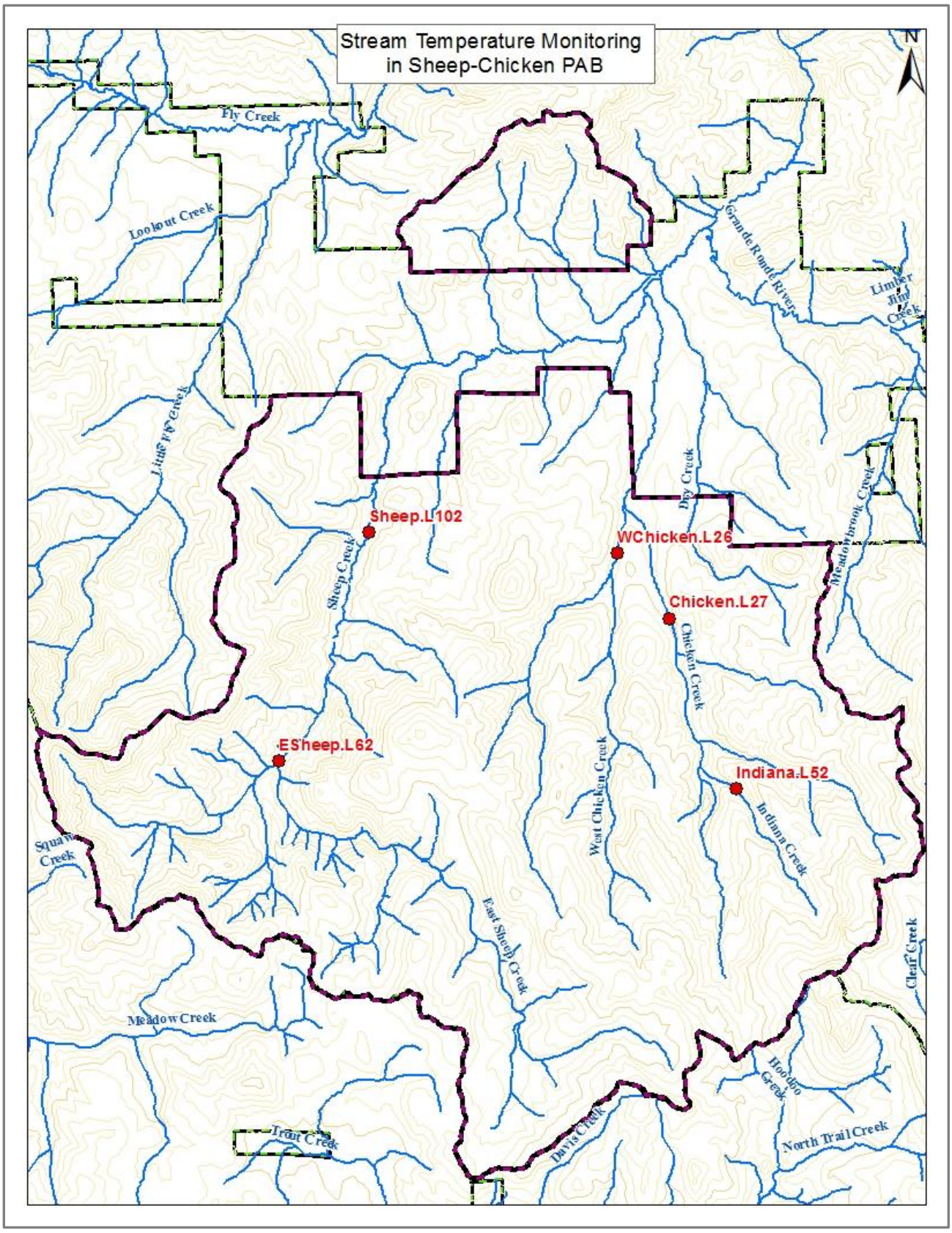

Figure 1. Temperature sites within the Sheep project area boundary.

Table 4. Temperature site locations, maximum temperatures and deviations from state standards.

Site Name	State Standard (°F)	Date of Maximum 7-day MAX (°F)	Maximum 7-day MAX (°F)	No. of Days Higher than State Standard	Difference from State Standard
Chicken.L27	60.8	8-Aug-10	56.0	0	-4.8
		29-Aug-11	56.0	0	-4.8
		15-Jul-12	58.9	0	-1.9
		5-Jul-13	59.3	0	-1.5
		17-Jul-14	60.1	0	-0.7
		5-Jul-15	60.0	0	-0.8
		31-Jul-16	58.6	0	-2.2
		4-Aug-17	58.5	0	-2.3
		12-Aug-18	58.5	0	-2.3
		6-Aug-19	57.1	0	-3.7
		31-Jul-20	57.4	0	-3.4
ESheep.L62	53.6	6-Aug-19	61.3	66	7.7
		1-Aug-20	59.7	58	6.1
Indiana.L52	53.6	10-Jul-17	56.0	58	2.4
		12-Aug-18	55.8	39	2.2
		6-Aug-19	55.1	10	1.5
		31-Jul-20	56.4	28	2.8
Sheep.L102	60.8	8-Aug-10	71.5	54	10.7
		6-Aug-11	70.2	74	9.4
		13-Jul-12	73.6	82	12.8
		5-Jul-13	75.0	94	14.2
		17-Jul-14	74.6	76	13.8
		6-Jul-15	74.5	87	13.7
		31-Jul-16	75.9	91	15.1
		4-Aug-17	74.5	86	13.7
		27-Jul-18	72.9	70	12.1
		3-Aug-19	66.1	64	5.3
		1-Aug-20	68.5	55	7.7
WChicken.L26	60.8	8-Aug-10	68.1	50	7.3
		29-Aug-11	66.5	52	5.7
		11-Aug-12	70.5	62	9.7
		23-Jul-13	72.0	84	11.2
		19-Jul-14	70.7	62	9.9
		6-Jul-15	71.0	74	10.2
		30-Jul-16	71.8	72	11.0
		4-Aug-17	70.7	84	9.9
		30-Jul-18	71.7	52	10.9
		6-Aug-19	70.6	63	9.8
		20-Aug-20	70.1	55	9.3

Table 4 shows that of all stream monitored, Chicken Creek is the only stream with temperatures consistently meeting its state standard of 60.8 deg F. State standards are based on the Designated Fish Use of that stream. Chicken, Sheep and West Chicken Creeks have a Designated Fish Use of Salmon & Trout Rearing and Migration. East Sheep and Indiana Creeks have a stricter state standard because their Designated Fish Use is for Bull Trout Spawning and Juvenile Rearing, so even though their temperatures are usually in the 50s they exceed the state standard for 1-2 months each summer depending on the year, and that is why the Chicken Subwatershed is considered impaired for Temperature Spawning.

Stream Condition – riparian vegetation, sediment and shade

Stream conditions are generally good in the Sheep project area. Most riparian areas have less deciduous riparian vegetation than desired, but no stream is in poor condition. Sheep, Chicken and West Chicken Creeks have recently had quite a bit of restoration work completed that aims at increasing woody debris in channels with the intent of increasing floodplain interactions and thereby storing water in the soil and increasing riparian vegetation.

There are a few roads in the project area with active erosion causing ruts or gullies, but no sediment deposition observed in nearby creeks. These roads were discussed at an IDT roads meeting and maintenance of those roads will occur before they are used for haul.

Densiometer measurements were taken in three RHCA units: Units 62 and 71 on East Sheep Creek and Unit 102 on Sheep Creek. Average canopy closure was high along the East Sheep Units and quite low in the Wetland unit along Sheep Creek. That is because the Wetland unit is a meadow and doesn't have (and shouldn't have) that many trees that shade the creek. It also doesn't have many hardwood shrubs which would be expected in a healthy meadow system.

Table 5. Average Canopy Closure in Riparian Treatment Units

Unit	Average Canopy Closure	Stream
62	78%	East Sheep Cr
71	80%	East Sheep Cr
102	19%	Sheep Cr

Springs/ Groundwater Dependent Ecosystems

A total of 11 spring sites were monitored within the Sheep project area, 8 of which were range water developments and 3 of those that are also water rights (Appendix A). Only one of those developments was not functioning, and while several had trampling and/or browsing impacts, those impacts were limited in aerial extent. These impacts are administrative issues that can be resolved through springs protection projects and increased maintenance and herding, and are not relevant to the Sheep project.

Regulatory Framework

Forest Plan and R6 Supplement

The Forest Plan Watershed Goal is to maintain or enhance the unique and valuable characteristics of riparian areas and to maintain or improve water quality, streamflows, wildlife habitat and fish habitat (USDA 1990, pp 4-22 to 4-26). The FS Manual R6 Supplement No. 2500.98-1 for Watershed Protection and Management provides additional guidance to plan and conduct land management activities so soil

and water quality are maintained or improved (USDA 1998). Standards and guidelines applicable to Sheep are listed below:

- Give management and enhancement of water quality, protection of watercourses and streamside management units, and fish habitat priority over uses described or implied in all other management standards or guidelines
- Meet Water Quality Standards for waters of the States of Oregon; application and monitoring of BMPs in conformance with the Clean Water Act.
- Implement Oregon Water Quality Management Plans (WQMPs) on lands administered by the Forest Service as described in MOU between ODEQ and USDA Forest Service.
- Prevent measurable temperature increases in Category 1 streams.
- Maintain natural large woody debris, plus trees needed for a future supply, to protect or enhance stream channel and bank structure, enhance water quality, and provide structural fish habitat within all streams.
- Enhance streambank vegetation and/or large woody debris where it can be effective in improving channel stability or fish habitat.
- Address the potential impacts to any wetlands within the project area. Adverse impacts to wetlands will be avoided or mitigated.

The Sheep project complies with watershed-relevant Forest Plan standards and guidelines.

Clean Water Act

The Clean Water Act (CWA) of 1972 and amendments require the restoration and maintenance of the chemical, physical, and biological integrity of the nation's waters. The State of Oregon has the authority to implement the CWA and it does so through setting water quality standards. These standards can be met by following the TMDL which is an approved plan to meet water quality standards and the Water Quality Restoration Plan (WQRP) which is the strategy for meeting the TMDL. In essence, the WQRP states that we will follow our Forest Plan (as amended), use Best Management Practices (BMPs) for all management activities, conduct BMP monitoring and temperature monitoring, and implement watershed restoration projects. The Sheep project is therefore consistent with the CWA.

Executive Orders 11998 and 11990

Actions included in Sheep do not propose to occupy floodplains or destroy or modify wetlands. Actions proposed in Alternative 2 will modify the Sheep Creek floodplain by cutting trees <9" dbh. This will enhance floodplain health by removing conifer encroachment. For these reasons, implementation of Sheep is consistent with Executive Orders 11988 and 11990 for floodplain management and protection of wetlands, respectively.

The Sheep analysis area does not intersect with a municipal watershed.

Environmental Impacts

The Sheep Creek and Chicken Creek Subwatersheds comprise the zone of influence for impacts to water resources, and ten years pre- and post-project comprise the period of influence.

Project Design Criteria and Mitigation Measures

BMPs that will be implemented with this project are found in the 2012 Forest Service BMP Technical Guide (USDA Forest Service, 2012) under the Aquatic Ecosystem (pg 19), Wildland Fire (pg 52), Road (pg 104) and Mechanical Vegetation (pg 128) Management Activities. Specific PDCs and Mitigation Measures

that will protect water quality are listed in the EA as well as Specialist Reports for Soils, Aquatics, Fuels and Engineering.

The standard RHCA width for a Category 4 waterbody is 100 feet and is maintained in most of the project area. But since the consultation concluded that the project "May Affect but is Not Likely to Adversely Affect" aquatic life and habitat, there is some flexibility allowed for that buffer. After monitoring many GDEs and all known springs and collaborating with the Soils Scientist, a 50-ft buffer was deemed an appropriate distance to provide adequate water resource protection.

Additional specific protection measures for water resources are not already listed in the Soils and Aquatics specialist reports are:

- Mitigations will be made for the GDE along FSR 5182-800
- Provide springs and GDEs a 50-ft buffer
- Remove all culverts in closed roads after use
- Do not permit sidecasting of maintenance-generated debris within RHCAs to avoid excavated materials entering waterbodies or riparian areas.
- Avoid or minimize unnecessary vegetation disturbance during road maintenance activities
- Temporary roads that are not on located on available old roadbeds should be located as far from waterbodies and wet soils (riparian areas, wetlands, meadows, bogs and fens) as practicable.

Alternative 1 No Action

There would be no direct or cumulative effects to water resources from this alternative. Indirect effects are increased likelihood of extreme fire behavior in riparian areas and accelerated conifer encroachment into riparian meadow systems and associated undesirable shifts in vegetation and habitat.

Alternative 2

Alternative 2 would involve some thinning in RHCAs. Modeling has shown that stream temperatures are far more sensitive to changes in shade than to changes in air temperature or discharge (Wondzell, *et al.* 2019). The amount of thinning proposed, however, is not likely to produce measurable reductions in shade for a number of reasons: (1) no thinning will occur within 50 feet of a stream channel; (2) thinning will only remove some trees beyond that 50-ft no activity buffer; (3) existing trees are not very tall and therefore most trees beyond 50 feet do not contribute directly to stream shade; and (4) there are many trees within that buffer that currently provide shade.

A recently published General Technical Review by the Rocky Mountain Research Station states that riparian areas occupy a small percentage of the natural landscape but have a disproportionate ecological importance relative to the area they occupy (Dwire *et al.* 2016). Dwire found that while many riparian areas are protected by administrative regulations, they have also been affected by fire suppression, land use, and human disturbance, so manipulative treatments of vegetation and other fuels may be needed in some locations to maintain riparian biodiversity and restore valued functions.

And a recent study by Roon, Dunham & Groom (2021) finds that solar radiation is a primary driver of energy budgets in small streams. However, where they performed light riparian thinning treatments (in the Lost Man Watershed) they found no increase in temperature response. This is likely because the treatment produced only 5% change in shade and did not increase solar radiation enough to affect

stream temperatures. However, it is also possible that the pervasive groundwater and hyporheic flow in this watershed could have mediated the influence of any increased solar radiation from thinning treatments on stream temperatures. But as we are looking for a way to make forested areas more resilient to wildfire, it is encouraging to note that changes in shade of 5% or less caused minimal changes in temperature while reductions of 20-30% resulted in much larger increases in stream temperature.

One place that we may want to actively treat in the future is in riparian meadow systems. Griffith *et al.* (2005) found that trees change soil characteristics where they grow, likely through the litter they produce, and in meadows, that change in the biogeochemical cycling appears to rapidly shift soil properties to support more trees rather than grass. After conifers have encroached on a meadow there is limited potential for recovery of most meadow species via the existing meadow seed bank because those seed banks lack 70% of the meadow species, and what remains is mostly just one species, the dominant sedge (Lang and Halpern, 2007; Haugo and Halpern, 2007). Once conifer invasions have begun, positive feedbacks can promote rapid conversion of meadow to forest (Halpern *et al.*, 2010). A more effective strategy for conservation of meadow systems is to remove or kill trees at an early stage before positive feedbacks lead to irreversible changes in soil properties and species composition (Haugo and Halpern, 2007).

Alternative 2 proposes thinning conifers that have encroached on a section of wet meadow along Sheep Creek in Unit 102, aka the Wetland unit. Not all trees will be cut: trees larger than 12" dbh will be retained as will trees that are providing shade, so we are not halting the biogeochemical processes that might favor conversion of the meadow to conifers, but we hope to slow down the process. For the Sheep project we are valuing the possible protection of stream temperatures above the likely protection of meadow ecosystems, but we may decide to do differently in a future project.

Ongoing activities that may affect water resources in the analysis area are OHV use in spring on native surface roads when they are wet and partially exposed, dispersed recreation near streams, and firewood gathering on wet roads and creation of user-created roads to get wood. The effects of these activities are localized and are very limited in magnitude, and will also not be considered in this analysis.

There are eight culverts approved for removal or replacement to improve fish passage as part of this project, and one that is completely plugged on a stored road (5182-040) that will be removed. These culvert projects have short term sedimentation effects but long term water resource benefits.

Table 6. Culverts Proposed for Removal or Replacement

FS Road	Stream	Proposed Action
5100-372	Indiana Cr	Remove old log deck bridge
5182-034	East Sheep Cr Tributary	Remove
5182-035	East Sheep Cr	Remove
5182-040	East Sheep Cr Tributary	Remove
5182-100	East Sheep Cr	Remove old log bridge crossing
5182-500	Sheep Creek Cr	Replace with AOP
5182-520	Sheep Junior Cr	Remove and replace with trail bridge
5184-000	Sheep Cr Tributary, lower culvert	Replace with AOP
5184-000	Sheep Cr Tributary, upper culvert	Replace with AOP

The few roads that are actively eroding sediment in the project area are proposed to be maintained to support haul activities. Maintenance activities generate sediment, but over time there would be an overall reduction in chronic sedimentation which would be a positive benefit to water resources. Sediment would also be generated when re-opening 24.5 miles of closed roads, reconstructing 13.4 miles of road and constructing 3.5 miles of temporary road (only 730 feet of which are mapped in RHCAs). All hand piles and grapple piles would be located outside of Blue Mountain PDC no activity buffers (PDC Fish-1) and it is unlikely that sediment from these areas would be transported through those buffers to nearby creeks. Prescribed fire is rarely known to generate sedimentation to creeks.

Direct effects from Alternative 2 include:

- No effect to stream temperature
- Minor amounts of sediment generated from maintenance activities and then haul traffic on roads; short term; a small negative impact
- Minor to moderate amounts of sediment generated from opening closed roads, temporary road construction and road reconstruction; short term; a small negative impact (low mileage overall and only 100 feet temp road in Cat 2 RHCA & 630 feet in Cat 4 RHCAs)
- Increased riparian access and minor amounts of associated bank trampling and riparian browsing; medium term; a small negative impact
- Minute and likely unmeasurable reductions in stream shade; no impact
- Fewer conifers in the Sheep Cr meadow; medium term; moderate positive impact

Alternative 3

Alternative 3 has less treatment area overall, no closed roads opened, no temporary roads constructed and no commercial treatment in RHCAs although the non-commercial treatment in the Wetland Unit would remain. Direct effects of this would be fewer log trucks driving and less sediment generated from road traffic, less sediment generated from road opening, road reconstruction and temporary road construction, no increase in riparian access, and no change to shade in the RHCA, all of which would be incrementally better for water resources. But not treating the RHCA units would potentially have future negative impacts on water resources through promotion of unnaturally dense and unhealthy stands of trees along waterways which would promote uncharacteristic fire behavior in those corridors.

Table 7. Indicators and Measures

Indicator	Measure	Alternative 2	Alternative 3
Estimated change in Stream Temperature	Acres of treatment within primary shade zone by stream, approximately 50 feet	0	0
Estimated change in Sedimentation from transportation system	Miles of temporary road in RHCAs	0.1	0

Issue: Treatment in RHCAs. Densiometer measurements taken pre-project in response to this issue in riparian thinning Units 62, 71 and 102 revealed that average canopy closure was 78%, 80% and 19% respectively (Appendix B). Measurements will be taken after thinning in the same locations for pre- and post-project comparison. We expect these values to remain unchanged after project activities.

Climate Change

Mean air temperatures have increased across the last century and this is predicted to continue over the next century due to climate change (USDA, 2017). Effects in the Sheep project area will include changes in precipitation type from less snow to more rain. This will likely lead to decreased snowpack and earlier melt resulting in shifts in both peak flows and low flows. Also, water temperatures are predicted to increase especially in middle elevations such as the Sheep project area.

To mitigate the effects of climate change, several tactics were identified in the Blue Mountain Climate Change Vulnerability Assessment (USDA, 2017) These include adding wood to streams and restoring beaver populations to reconnect floodplains, reduce drainage efficiency and maximize valley storage. Additionally, modifying livestock management while reducing surface fuels and forest stand densities will allow for more deciduous riparian vegetation which provides stream shading and reduces fire risk in the watershed. Another tactic identified in the assessment is increasing the resiliency of infrastructure to higher peak flows through installing higher capacity culverts and decommissioning or converting roads to alternative uses. These actions will improve natural flow regimes and decrease fragmentation of stream networks.

Both Alternatives will set the Sheep project area up for better success in the future, with Alternative 2 having a slightly better impact for climate change and for water resources.

Cumulative Effects

There is only one project for the past, present and foreseeable future that overlaps in time and space and would have an effect on water resources in the Sheep project area which is the upcoming Sheep Restoration and Stewardship Project which would benefit water resources. Other ongoing activities in the project area do not cause significant damage to water resources on their own or combined with the Sheep Project.

The Sheep Restoration and Stewardship project in conjunction with activities proposed in **Alternative 2** would balance out and produce **no measurable cumulative effect**; in conjunction with activities proposed in **Alternative 3** it would produce **no measurable cumulative effect** because the small amount of known beneficial cumulative effects would be countered by a small increase in unknown uncharacteristic fire and disease potential in the RHCA units left untreated.

Neither Alternative would produce significant adverse cumulative effects.

/s/ Dana M Nave, Hydrologist — Signature

8 July 2021 — Date

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Appendix A. Condition and maintenance needs of springs monitored in the Sheep project area, followed by select photos.

Name	Condition Spring/Pond*	Comments/Issues	Recommendation	Allotment
Pine Tree Trough	Not functioning	Inlet pipe cut and dribbling water onto the ground which flows to small pond in draw several feet away and infiltrates about 30 feet below pond. Trough is dry, rusty and has holes. Wet soils are trampled but limited in aerial extent.	Replace trough; fix inlet & outlet pipes; install escape ramp	Sheep Ranch
Mattock Trough	Functioning	Exclosure fence is partially down around spring source in draw. Draw is wet and trampled between springbox and trough. Trough is dry, in good condition and needs sticks cleaned out. Escape ramp in good condition. Wet soils are trampled but limited in aerial extent.	Expand exclosure fence to include 70 feet of draw downstream.	Sheep Ranch
Draw Pond	Functioning	Small pond in draw with water. No water in draw below pond. Minor trampling limited to edges of pond.	None	Sheep Ranch
M Avenue Pond (also a water right)	Functioning	Small pond in draw with water. Water in draw above and below pond. Light-to-moderate trampling in draw above pond.	More frequent herding	Sheep Ranch
Elk Loop Spring		Not inventoried		Sheep Ranch
Elk Loop Pond (also a water right)	Functioning	Small pond on hillside with water. No impacts when inventoried in June 2018.	None	Sheep Ranch
Soggy Pond		Not inventoried		Sheep Ranch
Pond 65 (also a water right)	Functioning	Small pond in draw with water. No water in draw above or below pond. Minor trampling limited to edges of pond.	None	Sheep Ranch
West Chicken Trough		Not inventoried fully. Location is good situated at road junction. Trough dry and did not appear to be hooked up to pipes.		Sheep Ranch

Name	Condition Spring/Pond*	Comments/Issues	Recommendation	Allotment
Upper Sheep Trough	Functioning	Trough full of water but close to creek so not fully reducing impacts to channel. Moving trough, however, is not realistic due to geomorphic constraints.	None	Sheep Ranch
Lower Sheep Trough	Functioning	Trough full of water. Small exclosure around spring source on road edge. Trough has no outlet pipe but no trampling observed during inventory. Needs an escape ramp.	Install escape ramp	Sheep Ranch
Sheep Trib Spring	Spring area; not a development	Source area for intermittent channel below; getting lots of livestock/wildlife use; heavily trampled; locally eroding stream channel and banks	Protect with fence; perhaps install springbox/trough away from channel	Sheep Ranch
Warm Mineral Springs Pond	Spring area; not a development	Pond in good condition when inventoried	None	Sheep Ranch
Mud Bog Spring	Spring area; not a development	Spring and associated mud bog downstream in good condition when inventoried. At start of FSR 5100-500.	None	Chicken Hill

Pine Tree Trough not functioning

Mattock Spring source area not protected

Warm Mineral Springs Pond in great condition

M Ave Pond; channel light-to-moderately trampled and browsed

Lower Sheep Spring and Trough in great condition with good flow

Sheep Trib Spring source area not protected and heavily trampled

Appendix B. Canopy Closure measured by Spherical Densiometer: Sheep VMP Units 71 & 62 on East Sheep Cr, and Unit 102 on Sheep Cr

Unit 71

Transect #1 (2-ft above water) **Location: Start**		Transect #2 (1-ft above water) **8 ft DS from T#1**		Transect #3 (1-ft above water) **40 ft DS from T#2**		Transect #4 (1.5-ft above water) **40 ft DS from T#3**	
Reading #	Hits (of 17	Reading #	Hits	Reading #	Hits	Reading #	Hits
1	14	1	15	1	11	1	17
2	14	2	17	2	14	2	12
3	11	3	12	3	11	3	15
4	11	4	14	4	14	4	15
Total:	50	Total:	58	Total:	50	Total:	59
% canopy closure	74%	% canopy closure	85%	% canopy closure	74%	% canopy closure	87%
Avg. Canopy Closure for Unit 71:	**80%**						

Unit 62

Transect #1 (1-ft above water) **Location: Start**		Transect #2 (1-ft above water) **40 ft DS from T#1**		Transect #3 (1-ft above water) **40 ft DS from T#2**		Transect #4 (1-ft above water) **40 ft DS from T#3**	
Reading #	Hits (of 17	Reading #	Hits	Reading #	Hits	Reading #	Hits
1	16	1	15	1	14	1	9
2	11	2	15	2	17	2	15
3	5	3	12	3	17	3	12
4	14	4	13	4	13	4	13
Total:	46	Total:	55	Total:	61	Total:	49
% canopy closure	68%	% canopy closure	81%	% canopy closure	90%	% canopy closure	72%
Avg. Canopy Closure for Unit 62:	**78%**						

Unit 102 (wetland unit)

Transect #1 (1-ft above water) **Location: Start**		Transect #2 (1-ft above water) **40 ft DS from T#1**		Transect #3 (1-ft above water) **40 ft DS from T#2**		Transect #4 (1-ft above water) **40 ft DS from T#3**	
Reading #	Hits (of 17	Reading #	Hits	Reading #	Hits	Reading #	Hits
1	0	1	0	1	14	1	0
2	0	2	0	2	0	2	0
3	0	3	0	3	6	3	9
4	0	4	0	4	16	4	8
Total:	0	Total:	0	Total:	36	Total:	17
% canopy closure	0%	% canopy closure	0%	% canopy closure	53%	% canopy closure	25%
Avg. Canopy Closure for Unit 102:	**19%**						